Name S-22, S-23, & C-15

Executive Summary

Application S-22 & S-23 received standard and incentives from Illinois DCEO for installing unitary AC units and VFDs on HVAC supply and return fans. The site also received custom incentives under project C-15 for the installation of demand control ventilation on the air conditioners serving the gym. The overall natural gas realization rate is 114%, and the electric realization rate is 118%.

Project Description

The participant installed (2) 10 Ton McQuay A/C units, (1) 7.5 Hp VFD on a supply fan, and (1) 3 Hp VFD on a return fan. The facility also installed demand control ventilation sensors and controls on HVAC units serving the gymnasium. The new controls are designed to regulate the amount of outside air being supplied, dependent upon the occupancy levels within the gymnasium. This results in energy savings by reducing the amount of unnecessary outdoor air at any given time while reducing load on the HVAC system.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the equipment was installed and operational and documented equipment nameplate information.

Standard Incentives

ELECTRIC ENERGY SAVINGS

ADM estimated energy savings resulting from the new unitary air conditioners using the Illinois TRM Version 2.0, Section 4.4.14 provided the following formula for electric energy savings:

For units with cooling capacities less than 65 kBtu/h:

$$\Delta kWH = (kBtu/h) * [(1/SEERbase) – (1/SEERee)] * EFLH$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWH = (kBtu/h) * [(1/EERbase) – (1/EERee)] * EFLH$$

Where:

kBtu/h	= capacity of the cooling equipment actually installed in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
SEERbase	= Seasonal Energy Efficiency Ratio of the baseline equipment; see table
SEERee	= Seasonal Energy Efficiency Ratio of the energy efficient equipment (actually installed).
EERbase	= Energy Efficiency Ratio of the baseline equipment; see table above for default values. Since IECC 2006 does not provide EER requirements for air-cooled air conditioners < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1

EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EERee is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.

= Actual installed

EFLH = cooling equivalent full load hours; see table

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW_{SSP} = (kBtu/h * (1/EERbase - 1/EERee)) * CF_{SSP}$$

Where:

CF_{SSP} = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

= 91.3%

For the supply and return fan VFDs, Section 4.4.17 (Version 2.0) Variable Speed Drives for HVAC was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kW_{connected} * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

Custom Incentives

NATURAL GAS ENERGY SAVINGS

ADM estimated energy savings according to the Illinois TRM Version 3.0, Section 4.4.19 Demand Control Ventilation.

$$\Delta Therms = \frac{SqFt}{1000} * SF$$

Where:

SqFt = Actual square footage of conditioned spaced controlled

SF = Therms savings factor based on building type and weather zone

ELECTRIC ENERGY SAVINGS

ADM estimated energy savings according to the Illinois TRM Version 3.0, Section 4.4.19 Demand Control Ventilation.

$$\Delta kWh = \frac{SqFt}{1000} * SF$$

Where:

SqFt = Actual square footage of conditioned spaced controlled

SF = kWh savings factor based on building type and weather zone

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for High Efficiency Unitary AC

Measure	*Measure Metrics*								*Annual Gross kWh Savings*	
	Program Type	*Equipment type*	*Subcategory or rating Condition*	*Qty*	*New Cooling Capacity (kbtu/h)*	*SEER of Efficient Equipment*	*Zone*	*Electric Resistance Heat?*	*Ex Ante*	*TRM-Calculated Ex Post*
Single-Package and Split System Unitary Air Conditioners	TOS	Air conditioners, Air cooled	Split System	2	120	12.8	2 (Chicago)	FALSE	993	977
Total									993	977

Annual kWh Savings for High Efficiency Unitary AC

Measure	*Measure Metrics*					*Annual Gross kWh Savings*	
	Application	*Program Type*	*Type*	*HP*	*Building Type*	*Ex Ante*	*TRM-Calculated Ex Post*
Variable Speed Drives for HVAC	AHU SF	TOS	HVAC	7.5 HP	School(K-12)	4,611	5,704
Variable Speed Drives for HVAC	AHU RF	TOS	HVAC	3 HP	School(K-12)	1,844	2,269
Total						6,455	7,973

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual kWh Savings for DCV

Measure	Measure Metrics				Annual Gross kWh Savings	
	Program Type	Building Type	Zone	Conditioned Space (Sq. Ft.)	Ex Ante	ADM Calculated Ex Post
DCV	TOS	Elementary	2 (Chicago)	5,452	2,800	3,173
Total					2,800	3,173

Annual Therms Savings for DCV

Measure	Measure Metrics				Annual Gross Therms Savings	
	Program Type	Building Type	Zone	Conditioned Space (Sq. Ft.)	Ex Ante	ADM Calculated Ex Post
DCV	TOS	Elementary	2 (Chicago)	5,452	350	398
Total					350	398

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings	
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh	Ex Post Peak kW Reduction
Standard	VFDs	6,455	7,973	124%	2.35	119,602	2.35
	HVAC	993	977	98%	1.09	14,658	1.09
Subtotal		7,448	8,950	120%	3.44	134,260	3.44
Custom	DDC	2,800	3,173	113%	0.00	31,731	0.00
Subtotal		*2,800*	*3,173*	*113%*	*0.00*	*31,731*	*0.00*
Total		***10,248***	***12,123***	***118%***	***3.44***	***165,991***	***3.44***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	DDC	350	398	114%	3,980
Total		***350***	***398***	***114%***	***3,980***

The overall 114% gas and 118% electric realization rates can be attributed the difference between the calculation methodologies used in the ex-ante and ex-post analysis. The ex-ante analysis relied on a straight deemed savings regardless of building type and weather zone, while ADM opted to use the methodology set forth by the Illinois TRM V3.0.

Name S-24

Executive Summary

Application S-24 received Standard incentives from Illinois-DCEO for retrofitting their exterior lighting. The realization rate for this project is 447%.

Project Description

The customer retrofitted (10) MH wall packs with (10) LED wall packs on the exterior

Methodology for Estimating Gross Savings.

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

Measure-level Gross Savings Results

Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					Annual Gross kWh Savings	
	Existing Wattage	Efficient Wattage	Hours	WHFe	Ex Ante	TRM-Calculated Ex Post
TOS/NC/RF - LED Bulbs and Fixtures	130	18.6	4903	1	1,222	5,462
Total					1,222	5,462

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Standard	4.5.4	1,222	5,462	447%	0.00	38,990
Total		***1,222***	***5,462***	***447%***	***0.00***	***38,990***

The project level realization rate is 447%. The realization rate is high because the ex ante savings estimate used 122 kWh per fixture while the ex post savings analysis utilized the TRM calculation of 546 kWh per fixture.

Name S-25

Executive Summary

Application S-25 received standard incentives from Illinois DCEO for retrofitting lighting and installation of VSDs on HVAC equipment in Building A, installation of VFDs on HVAC equipment in Building B, and installation of electric kitchen equipment in Building C. The applicant also received standard natural gas incentives from Illinois DCEO for installation of kitchen equipment in Building B. The electric realization rate for this project is 130% and the natural gas realization rate is 100%.

Project Description

The customer retrofitted and installed the following:

Building A:

- (315) 4' 2LT12 fixtures with (315) 4' 2LT8 fixtures
- (480) 4' 1LT12 fixtures with (480) 4' 1LT8 fixtures
- VSDs on (4) 5 HP hot water pumps
- VSDs on (1) 2 HP hot water pump

Building B:

- (1) Energy Star Oven
- (1) 25 Hp and (2) 40 Hp VFDs on HVAC fans

Building C:

- (1) ENERGY STAR Hot Food Holding Cabinet
- (1) ENERGY STAR Dishwasher

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operational. To verity the installed equipment, ADM field staff photographed equipment and nameplates and interviewed staff to determine equipment operation.

Building A:

Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.3 was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
WHF_e	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left(\frac{Watts_{base} - Watts_{EE}}{1000}\right) * WHF_d * CF * ISR$$

Where:

WHFd	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0, Section 4.4.17.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kW_{connected} * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

Building B:

Standard Incentives

NATURAL GAS ENERGY SAVINGS

Energy savings for the convection oven were calculated according to the Illinois TRM Version 2.0, Section 4.2.5 ENERGY STAR Convection Oven, which provides a deemed savings of 306 Therms.

ELECTRIC ENERGY SAVINGS

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0, Section 4.4.17.

$$\Delta kWH = kW_{connected} * Hours * ESF$$

Where:

kWConnected = kW of equipment is calculated using motor efficiency.

(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = kWconnected * DSF

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

Building C:

Standard Incentives

Energy savings for the hot food holding cabinet were calculated according to the Illinois TRM Version 2.0, Section 4.2.9.

ELECTRIC ENERGY SAVINGS

The TRM provides a deemed savings of 9,308 kWh per unit for full-size hot food holding cabinets, unless custom variables are known.

$\Delta kWh = HFHCBaselinekWh - HFHCENERGYSTARkWh$

Where:

$HFHCBaselinekWh = PowerBaseline * HOURSday * Days/1000$

$PowerBaseline = Custom$, *otherwise*

$HOURSday$ $= Average\ daily\ operation$

$= custom\ or\ if\ unknown, use\ 15\ hours$

$Days$ $= Annual\ days\ of\ operation$

$= custom$

$HFHCENERGYSTARkWh = PowerENERGYSTAR * HOURSday * Days/1000$

$PowerENERGYSTAR = Custom$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW $= \Delta kWh/AnnualHours$*CF

Where

$Hours$ $= Hoursday * Days$

$Hoursday$ $=$ Average daily operation

$= custom, or\ if\ unknown\ use\ 15\ hours$

$Days$ $= Annual\ days\ of\ operation$

$= custom$

Energy savings for the dishwasher were calculated according to the Illinois TRM Version 2.0, Section 4.2.6.

ELECTRIC ENERGY SAVINGS

The TRM provides a deemed savings value of 34,153 kWh for high-temperature, multi-tank conveyor dishwashers.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW $= \Delta kWh/AnnualHours$

Where

AnnualHours $= Hours * Days$

$= 365.25 * 18$

$= 6575\ annual\ hours$

Measure-level Gross Savings Results

Building A:

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Lighting Retrofit

Measure					*Annual Gross kWh Savings*	
	Existing Wattage	*Efficient Wattage*	*Hours*	*WHFe*	*Ex Ante*	*TRM-Calculated Ex Post*
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	80	49	3540	1.14	70,957	39,408
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	40	25	3540	1.14		29,056
Total					70,957	68,464

Annual kWh Savings for VFDs

Measure	*Measure Metrics*					*Annual Gross Savings*	
	Application	*Program Type*	*Motor Eff.*	*HP*	*Building Type*	*Ex Ante*	*TRM-Calculated Ex Post*
Variable Speed Drives for HVAC	Hot Water Pump	TOS	87.5%	5	College/ University	5,883	9,290
Variable Speed Drives for HVAC	Hot Water Pump	TOS	84.0%	5	College/ University	5,883	9,677
Variable Speed Drives for HVAC	Hot Water Pump	TOS	84.0%	5	College/ University	5,883	9,677
Variable Speed Drives for HVAC	Hot Water Pump	TOS	88.0%	5	College/ University	5,883	9,237
Variable Speed Drives for HVAC	Hot Water Pump	TOS	84.0%	2	College/ University	2,353	3,871
Total						25,885	41,752

Building B:

Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

Annual Therms Savings for Convection Oven

Measure	*Measure Metrics*		*Annual Gross Therms Savings*	
	Program Type	*Qty*	*Ex Ante*	*TRM-Calculated Ex Post*
ENERGY STAR Convection Oven	TOS	1	305	306
Total			305	306

Annual kWh Savings for VFDs

Measure	*Measure Metrics*					*Annual Gross Savings*	
	Application	*Program Type*	*Type*	*HP*	*Building Type*	*Ex Ante kWh*	*TRM-Calculated Ex Post kWh*
Variable Speed Drives for HVAC	Constant Volume Fan	TOS	HVAC	25	College/ University	29,414	48,507
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	40	College/ University	47,063	61,936
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	40	College/ University	47,063	61,936
Total						123,540	172,379

Building C:

Savings for Hot Food Holding Cabinet

Measure	*Measure Metrics*				*Annual Gross Savings*	
	Program Type	*Cabinet Size*	*Qty*	*Annual Hours*	*Ex Ante kWh*	*TRM-Calculated Ex Post kWh*
ENERGY STAR Hot Food Holding Cabinet	TOS	Full size	1	3,913	9,314	3,913
Total					9,314	3,913

Annual kWh Savings for Dishwasher

Measure	*Measure Metrics*			*Annual Gross Savings*	
	Program Type	*Qty*	*Dishwasher Type*	*Ex Ante kWh*	*TRM-Calculated Ex Post kWh*
ENERGY STAR Dishwasher	TOS	1	High Temp Multi-Tank Conveyor	17,465	34,153
Total				17,465	34,153

Project-level Gross Savings Results

The tables shown below present the verified electric gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Location*	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
			Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	Building A	T8 Fixtures and Lamps	70,957	68,464	96%	14.25	511,137
	Building A	Variable Speed Drives for HVAC	25,885	41,752	161%	0.00	626,280
Subtotal			96,842	110,216	114%	14.25	1,137,417
Standard	Building B	Variable Speed Drives for HVAC	123,540	172,379	140%	27.82	2,585,687
Subtotal			123,540	172,379	140%	27.82	2,585,687
Standard	Building C	ENERGY STAR Hot Food Holding Cabinet	9,314	3,913	42%	0.36	46,961
	Building C	ENERGY STAR Dishwasher	17,465	34,153	196%	5.19	683,060
Subtotal			26,779	38,066	142%	5.55	730,021
Total			***247,161***	***320,661***	***130%***	***47.62***	***4,453,125***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Location*	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
			Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	Building B	Oven	305	306	100%	3,672
Total			***305***	***306***	***100%***	***3,672***

The overall project electric realization rate is 130% and the gas realization rate is 100%.

For Building A the lighting retrofit, the realization rate is slightly low due to the ex ante estimate for reduced wattage T8 lamps applying a savings of 64.51 kWh per lamp, while the ex post utilized the TRM calculation for reduced wattage T8 lamps in a university, ranging from 60.53 kWh to 62.55 kWh per lamp. The ex-ante electric savings estimate for VFDs uses a deemed savings of 1,176.6 kWh per controlled HP based on a "University" facility type, but other assumptions are unknown. The Illinois TRM version 2.0 determines hours of operation based on

HVAC application and building type and determines energy savings factor based on VFD application, resulting in savings of 1,897.8 kWh per controlled HP.

Building B's ex-ante electric savings estimate for VFDs uses a deemed savings of 1,176.6 kWh per controlled HP for a "University" facility type, but other assumptions are unknown. The Illinois TRM version 2.0 determines hours of operation based on HVAC application and building type and determines energy savings factor based on VFD application, resulting in an electric realization rate of 140%.

For Building C the ex-ante savings estimation for the hot food holding cabinet used a deemed savings of 9,314 kWh per unit for a full size cabinet. The Illinois TRM v2.0, however, requires custom variables when available to determine savings, which resulted in a savings of 3,913 kWh and a realization rate of 42%.

Name S-26

Executive Summary

Application S-26 received standard incentives from Illinois DCEO for installation of ground source heat pumps at a newly constructed facility. The electric realization rate for this project is 111%.

Project Description

The customer installed the following a total of 139 ground source heat pumps ranging from one ton to 30 tons. The ground source heat pumps were installed at a newly constructed facility and utilize a series of ground wells to maintain a high efficiency during periods of extreme weather temperatures.

During the site visit and documentation review, it was discovered that the site also applied for incentives for the installation of VFDs on two 10hp chilled water pumps; however neither savings nor incentives were allocated for this measure.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verity the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

ADM estimated the ground source heat pump energy savings according to the Illinois TRM Version 2.0, Section 4.4.9 Heat Pump Systems.

ELECTRIC ENERGY SAVINGS

For units with cooling capacities less than 65 kBtu/h:

$$\Delta kWh = \text{Annual kWh Savings}_{cool} + \text{Annual kWh Savings}_{heat}$$

$$\text{Annual kWh Savings}_{cool} = (kBtu/h_{cool}) * [(1/SEERbase) - (1/SEERee)] * EFLH_{cool}$$

$$\text{Annual kWh Savings}_{heat} = (kBtu/h_{cool}) * [(1/HSPFbase) - (1/HSPFee)] * EFLH_{heat}$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWh = \text{Annual kWh Savings}_{cool} + \text{Annual kWh Savings}_{heat}$$

$$\text{Annual kWh Savings}_{cool} = (kBtu/h_{cool}) * [(1/EERbase) - (1/EERee)] * EFLH_{cool}$$

$$\text{Annual kWh Savings}_{heat} = (kBtu/h_{heat})/3.412 * [(1/COPbase) - (1/COPee)] * EFLH_{heat}$$

Where:

$kBtu/h_{cool}$ = capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).

	= Actual installed
SEERbase	=Seasonal Energy Efficiency Ratio of the baseline equipment; see table below for values.
SEERee	= Seasonal Energy Efficiency Ratio of the energy efficient equipment.
	= Actual installed
$EFLH_{cool}$	= cooling mode equivalent full load hours
HSPFbase	= Heating Seasonal Performance Factor of the baseline equipment; see table above for values.
HSPFee	= Heating Seasonal Performance Factor of the energy efficient equipment.
	= Actual installed
$EFLH_{heat}$	= heating mode equivalent full load hours; see table above for default values.
EERbase	= Energy Efficiency Ratio of the baseline equipment; see the table above for values. Since IECC 2006 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
EERee	= Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EERee is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.
	= Actual installed
$kBtu/h_{heat}$	= capacity of the heating equipment in kBtu per hour.
	= Actual installed
3.412	= Btu per Wh.
COPbase	= coefficient of performance of the baseline equipment; see table above for values.
COPee	= coefficient of performance of the energy efficient equipment.
	= Actual installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (kBtu/h_{cool}) * [(1/EERbase) - (1/EERee)] * CF$$

CF_{SSP}	= Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)
	= 91.3%
CF_{PJM}	= PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected * Hours * ESF$$

Where:

kWConnected	= kW of equipment is calculated using motor efficiency. (HP * .746 kw/hp* load factor)/motor efficiency Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.
Hours	= Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.
ESF	= Energy savings factor varies by VFD application.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kWconnected * DSF$$

Where:

DSF	= Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for Ground Source Heat Pumps

Measure	*Measure Metrics*									*Annual Gross kWh Savings*		
	Program Type	*Equipment Type*	*Electric Resistance heat?*	*Qty*	*Cooling Capacity (kBtu/H)*	*Heating Capacity (kBtu/H)*	*SEERee*	*HSPFee*	*Zone*	*Ex Ante*	*TRM-Calculated* Ex Post	*ADM Calculated* Ex Post
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*5*	*14.2*	*10.5*	*17.5*	*11.6*	*3 (Springfield)*		*1,146*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*10*	*16.6*	*13.3*	*16.6*	*10.6*	*3 (Springfield)*		*1,269*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*2*	*18.5*	*14.7*	*20.9*	*14.0*	*3 (Springfield)*		*1,341*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*8*	*21.7*	*15.0*	*23.1*	*13.6*	*3 (Springfield)*		*6,526*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*27.2*	*19.5*	*20.5*	*14.3*	*3 (Springfield)*		*944*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*12*	*29.4*	*20.0*	*24.1*	*13.6*	*3 (Springfield)*		*13,817*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*20*	*35.5*	*29.1*	*18.0*	*12.5*	*3 (Springfield)*		*16,191*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*35.0*	*24.1*	*24.2*	*15.0*	*3 (Springfield)*		*1,525*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*40.2*	*27.0*	*22.1*	*14.3*	*3 (Springfield)*		*1,502*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*42.0*	*27.5*	*23.5*	*14.3*	*3 (Springfield)*		*1,669*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*14*	*49.8*	*36.2*	*18.8*	*12.1*	*3 (Springfield)*		*15,483*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*2*	*50.0*	*37.4*	*19.8*	*14.0*	*3 (Springfield)*		*3,262*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*3*	*49.3*	*35.3*	*21.7*	*13.6*	*3 (Springfield)*		*5,206*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*30*	*57.4*	*46.1*	*17.7*	*11.4*	*3 (Springfield)*		*28,107*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*4*	*66.8*	*43.2*	*21.5*	*13.3*	*3 (Springfield)*		*9,210*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*2*	*67.6*	*45.8*	*19.8*	*13.3*	*3 (Springfield)*		*4,153*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*83.0*	*55.0*	*21.7*	*12.6*	*3 (Springfield)*		*2,729*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*7*	*76.0*	*51.3*	*19.5*	*11.9*	*3 (Springfield)*		*13,088*	
GSHP	*NC*	*Ground Source Heat Pump*	*FALSE*	*1*	*109.1*	*82.1*	*17.9*	*13.2*	*3 (Springfield)*		*2,802*	
GSHP	*NC*	*Ground Source*	*FALSE*	*3*	*122.0*	*83.0*	*19.8*	*12.3*	*3*		*9,881*	

Measure	Measure Metrics									Annual Gross kWh Savings		
	Program Type	Equipment Type	Electric Resistance heat?	Qty	Cooling Capacity (kBtu/H)	Heating Capacity (kBtu/H)	SEERee	HSPFee	Zone	Ex Ante	TRM-Calculated Ex Post	ADM Calculated Ex Post
		Heat Pump							(Springfield)			
GSHP	NC	Ground Source Heat Pump	FALSE	3	171.0	97.0	23.1	12.6	3 (Springfield)			31,491
GSHP	NC	Ground Source Heat Pump	FALSE	1	185.0	109.0	20.4	11.6	3 (Springfield)			9,620
GSHP	NC	Ground Source Heat Pump	FALSE	3	246.0	184.0	19.1	13.0	3 (Springfield)			43,287
GSHP	NC	Ground Source Heat Pump	FALSE	1	274.3	190.0	20.4	14.3	3 (Springfield)			17,698
GSHP	NC	Ground Source Heat Pump	FALSE	2	291.0	224.0	20.9	14.3	3 (Springfield)			40,296
GSHP	NC	Ground Source Heat Pump	FALSE	1	430.6	315.9	17.5	12.6	3 (Springfield)			22,070
Total										275,326	139,850	164,460

It should be noted that the last six line items shown in the above Ground Source Heat Pump savings table are being reported under the "ADM Calculated" field. This is due to the Illinois TRM Version 2.0, Section 4.4.9 Heat Pump Systems, only providing baseline efficiencies for ground source heat pumps with capacities under 135,000 Btus/hr. Due to this limitation ADM, relied on the efficiencies set forth by the federal appliance standards[20] for all units above 135,000 Btus/hr.

[20] http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/77

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Standard	GSHPs	275,326	304,310	111%	179.64	4,564,652
Total		***275,326***	***304,310***	***111%***	***179.64***	***4,564,652***

The electric realization rate of 111% can be attributed can be attributed to the ex-ante analysis aggregating the total tons of the ground source heat pump units in the savings estimation. The ex post analysis calculated the savings for each unit based on size. Units under 135,000 Btus/hr were calculated with the TRM Version 2.0, Section 4.4.9 Heat Pump Systems and units over were calculated with EERE appliance standards.

Name S-27

Executive Summary

Application S-27 received standard incentives from Illinois DCEO for installation of a high efficiency boiler and VFDs on pumps. The electric realization rate for this project is 111%, and the natural gas realization rate is 77%.

Project Description

The customer installed (2) new high efficiency boilers, but only one is used at a time. The installed boilers have an efficiency of 96% AFUE. VFDs were also installed on a 5 HP, a 7.5 HP, and (3) 3 HP hot water pumps.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

Energy savings were calculated according to the Illinois TRM Versions 2.0 and 3.0 (errata corrected).

For the boiler incentives, TRM Version 3.0, Section 4.4.10 High Efficiency Boiler was used.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = EFLH * Capacity * ((EffRating_{actual} - EffRating_{base})/EffRating_{base}) / 100{,}000$$

Where:

EFLH	= Equivalent Full Load Hours for heating (see table)
Capacity	= Nominal Heating Input Capacity Boiler Size (btuh)
	= custom Boiler input capacity in Btu/hr
EfficiencyRating(base)	= Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section
EfficiencyRating(actual)	= Efficent Boiler Efficiency Rating use actual value

For the pump VFDs, Section 4.4.17 (Version 2.0) Variable Speed Drives for HVAC was used.

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWconnected* Hours * ESF$$

Where:

kWConnected	= kW of equipment is calculated using motor efficiency.
	(HP * .746 kw/hp* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.

ESF = Energy savings factor varies by VFD application.

Application	ESF
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kW_{connected} * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for VFDs on Pumps

Measure	Application	Program Type	Type	HP	Building Type	Annual Gross kWh Savings	
						Ex Ante	TRM-Calculated Ex Post
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	7.5 HP	School(K-12)	4,611	5,139
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	5 HP	School(K-12)	3,074	3,430
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	3 HP	School(K-12)	1,844	2,044
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	3 HP	School(K-12)	1,844	2,044
Variable Speed Drives for HVAC	Hot Water Pump	RF	HVAC	3 HP	School(K-12)	1,844	2,044
Total						13,218	14,702

Annual Therms Savings for High Efficiency Boilers

Measure	Program Type	Boiler btuh	Base Boiler Type	Efficient Measure	Zone	Building Type	Annual Gross Therms Savings		
							Ex Ante	TRM-Calculated Ex Post	TRM-Calculated (Errata Corrected) Ex Post
High Efficiency Boiler	RF	2,000,000	Hot Water ≥300,000 & ≤2,500,000 Btu/h	AFUE ≥ 96%	1 (Rockford)	Elementary	4,200	3,500	3,228
Total							4,200	3,500	3,228

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Standard	Variable Speed Drives for HVAC	13,218	14,702	111%	0.00	220,527
Total		***13,218***	14,702	111%	0.00	220,527

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	High Efficiency Boiler	4,200	3,228	77%	64,560
Total		***4,200***	***3,228***	***77%***	***64,560***

The 111% verified electric realization rate is due to the ex post using the actual building type. The building type affects the hours of the equipment. The ex ante likely used an average for the hours.

The 77% verified natural gas realization rate is due to savings being claimed for two boilers when only one is used at a time. The other factor affecting realized savings is that the ex post used TRM Version 3.0, which has EFLH associated with an elementary school. The ex ante likely used an average for the EFLH.

Name C-16

Executive Summary

Application C-16 upgraded its HVAC operating procedures, including turning off reheat during summer months. No new hardware is installed; this is a change in operating procedures. The natural gas realization rate is 126%.

Project Description

The applicant implemented a change in the control strategy and set-points of their central plant hot water loops which significantly reduced re-heat during summer months (beginning June 1st and ending mid-September). The heating system for the airport is a centralized superheated water system with 8 "boilers". The low temperature water loop that feeds the reheat coils, radiant panels, etc. is heated by heat exchangers between the high temperature water loop and the low temperature loop. The high temperature water loop supply temperature set-point is 400F during cold months, and is now reduced down to around 250F during summer months. Space thermostat set points are at 75F in the summer and 72F in the winter. The low temperature loops that feed the reheat coils have their temperatures read at the pumps. They were turned down from 160F to 70F for this project (during summer months).

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the Hot water loop set-point changes were implemented. To verify the energy savings for the measures, ADM field staff documented boiler equipment, loop temperatures, and site maps. Furthermore, ADM staff reviewed the set-points in the building energy management system to verify operations. The Ex Post annual energy impact estimates for this project are estimated using IPMVP Option C (Whole Facility Billing Analysis). Billing histories were requested for all gas meters listed under the facilities utility account. These billing data were transformed into observation so *Therms Per Day* for each billing period and then regressed against Heating Degree Days (HDD) and Cooling Degree Days (CDD). The final regression equation took the following form.[21] The *X* in the equation below indicates a cross product of the terms.

$$Therms_{Per\ Day} = Meter_{Dummy} \times HDD \times PrePost \times CDD$$

Where:

$Meter_{Dummy}$ = Is a dummy variable used to represent each meter for which billing data was regressed.

HDD = The heating degree days for each billing period. Note that the regression found that a base of 60 degrees resulted in the optimum fit.

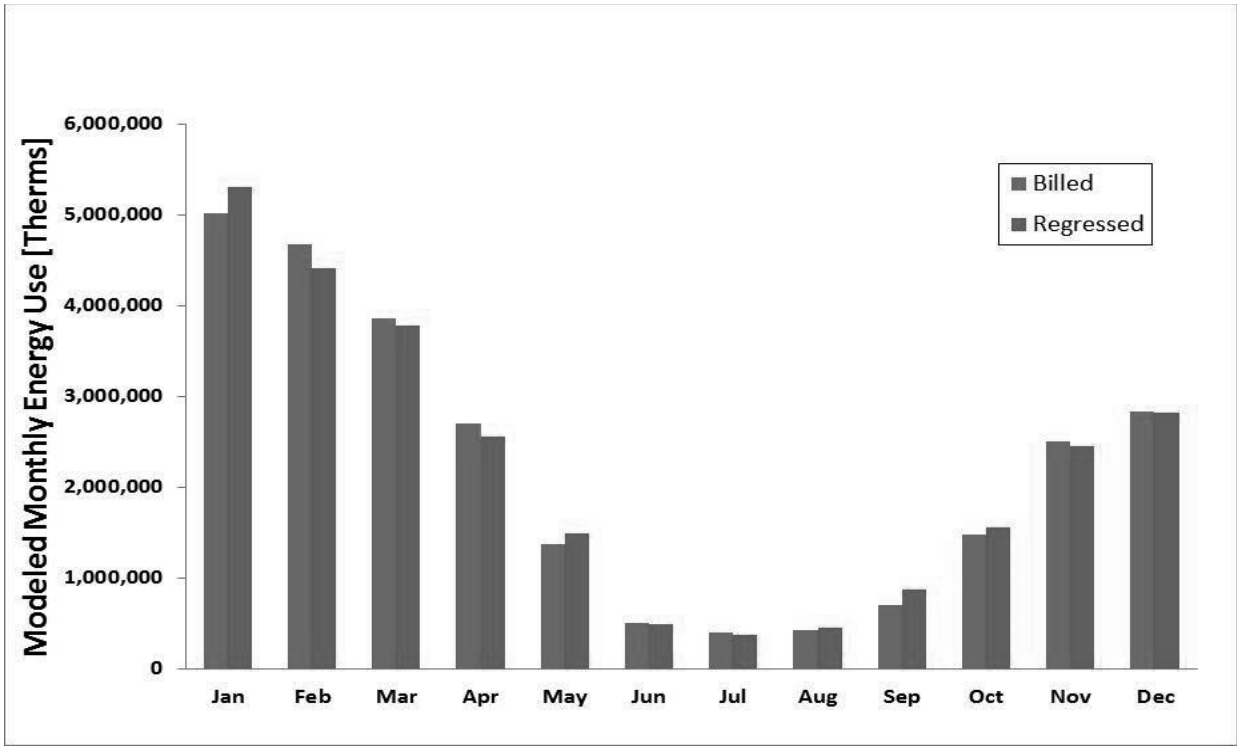
[21] Note that equation shown is the general form of the final regression equation, The only difference is that several terms were removed from the final cross-product due to a lack of significance and/or appropriateness in physical first principles.

CDD	= The cooling degree days for each billing period. Note that the regression found that a base of 65 degrees resulted in the optimum fit.
PrePost	= A dummy variable used to represent differences in energy usage between the baseline and post periods.

The following graphic illustrates the monthly regressed total gas usage for the facility against the actual billing history for one year in the baseline period (2012). Regressions were generated using the R statistical analysis software and final regression coefficients are provided in the following table Note that the measure(s) implemented only reduce the hot water loop temperature during the summer months. As such, the only components of the regression model for which savings can be attributed to this measure are coefficients in which the *PrePost* variable interacts with the *CDD* variable.

Heating and cooling degree days were calculated using recorded weather data[22] for the same period as the billing histories. These weather data were used to derive the regression coefficients listed in the table below. Once the regression coefficients were derived, HDD and CDD values were re-calculated using TMY3 weather data for the facility and the regression coefficients were applied to the "typical" weather data in order to derive weather normalized impact estimates.

Comparison of Bills and Regressed Usage



[22] Downloaded from the National Oceanic and Atmospheric Administration's (NOAA's) FTP site.

List of Regression Coefficients and their Values

Coefficient Term	*Estimate*	*Std. Error*	*t value*	*Pr(>|t|)*
(Intercept)	1.52E+04	3.71E+02	41.009	< 2e-16
Account.Number A	-1.52E+04	5.25E+02	-28.995	< 2e-16
Account.Number B	-1.51E+04	4.93E+02	-30.579	< 2e-16
Account.Number C	-1.52E+04	5.25E+02	-29.005	< 2e-16
Account.Number D	-1.52E+04	5.10E+02	-29.792	< 2e-16
Account.Number E	-1.52E+04	5.25E+02	-28.985	< 2e-16
Account.Number F	-1.52E+04	5.25E+02	-28.994	< 2e-16
Account.Number G	-1.52E+04	5.25E+02	-28.974	< 2e-16
Account.Number H	-1.43E+04	5.25E+02	-27.255	< 2e-16
Account.Number I	-1.51E+04	4.94E+02	-30.614	< 2e-16
HDD60	3.45E+01	5.07E-01	68.063	< 2e-16
PrePost	-1.70E+03	3.80E+02	-4.46	1.26E-05
Account.Number A:HDD60	-3.43E+01	7.17E-01	-47.824	< 2e-16
Account.Number B:HDD60	-3.45E+01	7.08E-01	-48.718	< 2e-16
Account.Number C:HDD60	-3.43E+01	7.17E-01	-47.833	< 2e-16
Account.Number D:HDD60	-3.45E+01	7.56E-01	-45.631	< 2e-16
Account.Number E:HDD60	-3.42E+01	7.17E-01	-47.769	< 2e-16
Account.Number F:HDD60	-3.42E+01	7.17E-01	-47.758	< 2e-16
Account.Number G:HDD60	-3.44E+01	7.17E-01	-47.989	< 2e-16
Account.Number H:HDD60	-3.10E+01	7.17E-01	-43.251	< 2e-16
Account.Number I:HDD60	-3.39E+01	7.10E-01	-47.762	< 2e-16
Account.Number A:PrePost	1.71E+03	5.38E+02	3.174	0.001699
Account.Number B:PrePost	1.66E+03	5.38E+02	3.083	0.002285
Account.Number C:PrePost	1.68E+03	5.38E+02	3.123	0.002009
Account.Number D:PrePost	1.68E+03	6.27E+02	2.683	0.007808
Account.Number E:PrePost	1.69E+03	5.38E+02	3.143	0.001883
Account.Number F:PrePost	1.74E+03	5.38E+02	3.228	0.001421
Account.Number G:PrePost	1.70E+03	5.38E+02	3.168	0.001735
Account.Number H:PrePost	1.54E+03	5.38E+02	2.861	0.004594
Account.Number I:PrePost	1.61E+03	5.38E+02	3	0.002982
Account.Number J:CDD65	-2.04E+01	1.67E+00	-12.179	< 2e-16

Coefficient Term	*Estimate*	*Std. Error*	*t value*	*Pr(>|t|)*
Account.Number A:CDD65	-6.34E-03	1.67E+00	-0.004	0.996981
Account.Number B:CDD65	-3.86E-01	1.58E+00	-0.245	0.806798
Account.Number C:CDD65	1.26E-02	1.67E+00	0.008	0.99399
Account.Number D:CDD65	-5.49E-02	1.63E+00	-0.034	0.973096
Account.Number E:CDD65	-1.80E-02	1.67E+00	-0.011	0.991438
Account.Number F:CDD65	1.77E-02	1.67E+00	0.011	0.991556
Account.Number G:CDD65	1.65E-04	1.67E+00	0	0.999922
Account.Number H:CDD65	-2.74E+00	1.67E+00	-1.634	0.103631
Account.Number I:CDD65	-3.03E-01	1.58E+00	-0.192	0.847866
PrePost:CDD65	-1.13E+01	3.19E+00	-3.539	0.000482
Account.Number A:PrePost:CDD65	1.12E+01	4.52E+00	2.487	0.01355
Account.Number B:PrePost:CDD65	1.12E+01	4.53E+00	2.467	0.014336
Account.Number C:PrePost:CDD65	1.14E+01	4.52E+00	2.522	0.012306
Account.Number D:PrePost:CDD65	1.13E+01	6.39E+00	1.773	0.077446
Account.Number E:PrePost:CDD65	1.13E+01	4.52E+00	2.505	0.012899
Account.Number F:PrePost:CDD65	1.11E+01	4.52E+00	2.452	0.014931
Account.Number G:PrePost:CDD65	1.12E+01	4.52E+00	2.487	0.013576
Account.Number H:PrePost:CDD65	1.02E+01	4.52E+00	2.262	0.024622
Account.Number I:PrePost:CDD65	1.16E+01	4.53E+00	2.554	0.011277

Measure-level Gross Savings Results

Custom Incentives

The table below presents the verified gross savings for measures that received Custom incentives.

Annual Therms Savings for Project Renovations

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated Ex Post*
Hot Water Loop Set-Point Set-Back	233,175	294,512
Total	233,175	294,512

Project-level Gross Savings Results

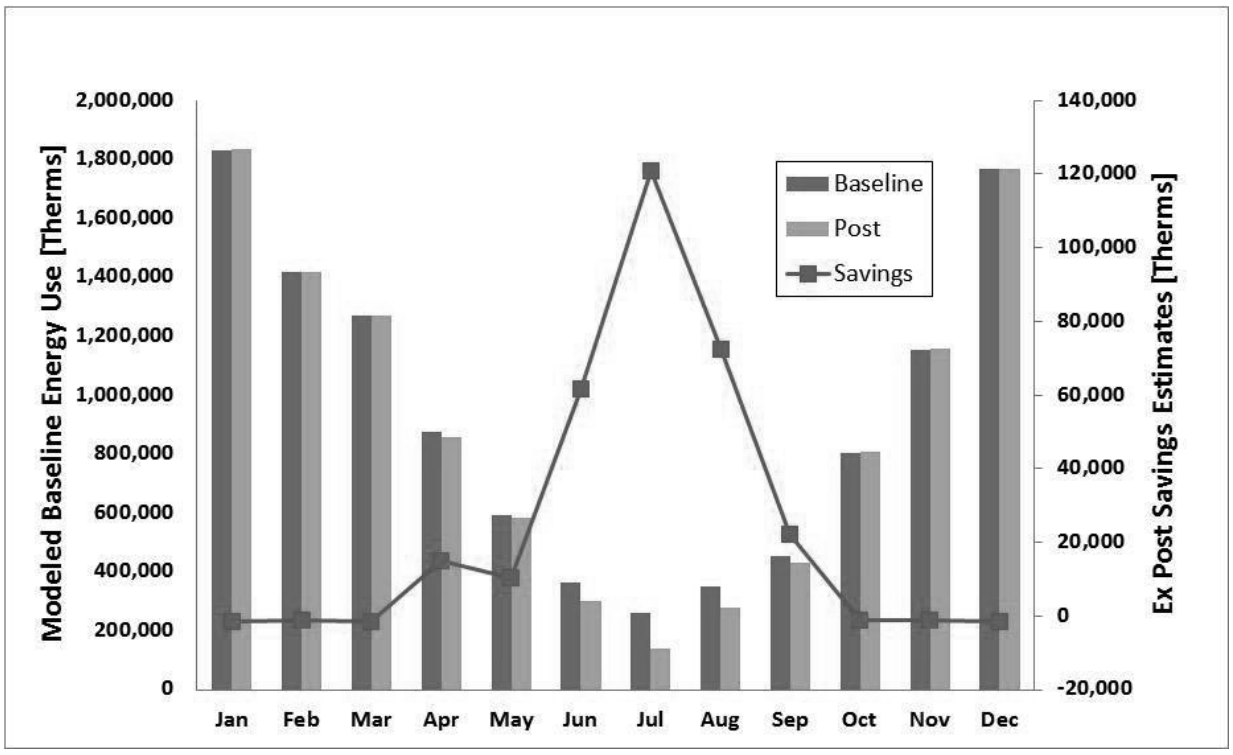
The tables shown below present the verified gross savings for this project.

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	Hot Water Loop Set-Point Set-Back	233,175	294,512	126%	4,417,680
Total		***233,175***	***294,512***	***126%***	***4,417,680***

The verified gas impacts are higher than the ex-ante estimates (126% realization rate). This can be attributed to differences between the approaches used to derive each estimate. The Ex Ante estimates were based on engineering assumptions and formulas (IPMVP Option A) while the Ex Post estimates are based on a billing history regression analysis (IPMVP Option C). Results from the billing analysis (comparing "typical" baseline and post periods) are below:

Summary of Ex-Post Savings Estimates



Name S-28, C-17

Executive Summary

Application S-28, C-17 received standard and custom incentives from DCEO for installation of a Storage Water Heater and cutting down ventilation rate during unoccupied periods via DDC. The natural gas realization rate is 70%.

Project Description

The customer installed (4) new high efficiency storage water heaters. DDC reduced ventilation rate on multiple air handlers during unoccupied hours, effectively reduce overall 9,255 CFM of heating load.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates.

Standard Incentives

For the Storage Water Heater incentives, Illinois TRM Version 2.0, Section 4.3.1 Storage Water Heater was used. The facility installed water heaters that have thermal efficiency of 92%. Per TRM's definition, the thermal efficiency is greater than 88% and the installed equipment are high efficiency storage water heater. The high efficiency units have deemed annual natural gas savings of 251 Therms/year/unit.

Custom Incentives

Energy savings were calculated using engineering equation and outdoor temperature during unoccupied hours.

$$Sensible\ Heat\ Savings\ (Btuh) = 1.08\ \times \left(T_{setpoint} - T_{outdoor}\right) \times \left(CFM_{base} - CFM_{as\_built}\right)$$

Where:

1.08	= Conversion Factor, 1.08 min/hour x Btu/ft^3 °F
$T_{setpoint}$	= Heating system temperature setpoint, 70 °F
$T_{outdoor}$	= Outside air temperature based on TMY3 weather data (°F)
CFM_{base}	= Baseline ventilation airflow rate, 17,309 CFM
CFM_{as_built}	= As built ventilation airflow rate, 8,054 CFM

The HVAC system keeps neutral pressure inside, the system bring equal amount of outside air as the amount of air ventilated out. The total gas savings is calculated as follows,

$$Gas\ Savings\ (Therms) = \frac{\sum_{hour=1}^{8760} Sensible\ Heat\ Savings}{Heating\ System\ Efficiency\ \times 100{,}000}$$

Where:

Heating System Efficiency= Heating System Efficiency, 83%

100,000 = Conversion Factor, 100,000 Btuh/therm

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual Gas Savings for Storage Water Heaters

Measure	*Measure Metrics*					*Annual Gross Therms Savings*	
	Program Type	*Measure Type*	*Qty.*	*Tank Size*	*Building Type*	*Ex Ante*	*TRM-Calculated Ex Post*
Storage Water Heater	TOS	Gas,High Efficiency	4	80 gallons	Education – Primary/Secondary	224	1,004
Total						224	1,004

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Gas Savings for Ventilation Reduction

Temperature Range	*Hours*	CFM_{base}	CFM_{as_built}	*Annual Gross Therms Savings*	
				Ex Ante	*Ex Post*
-20 to -16	2	17,309	8,054	21	21
-15 to -11	15	17,309	8,054	110	149
-10 to -6	16	17,309	8,054	254	151
-5 to -1	14	17,309	8,054	466	122
0 to 4	47	17,309	8,054	729	387
5 to 9	52	17,309	8,054	872	392
10 to 14	98	17,309	8,054	1,145	693
15 to 19	131	17,309	8,054	1,474	821
20 to 24	109	17,309	8,054	2,133	629
25 to 29	212	17,309	8,054	3,003	1,101
30 to 34	224	17,309	8,054	3,839	1,023
35 to 39	355	17,309	8,054	2,639	1,398
40 to 44	346	17,309	8,054	1,581	1,161
45 to 49	406	17,309	8,054	1,066	1,149
50 to 54	488	17,309	8,054	0	1,047
55 to 59	326	17,309	8,054	0	521
60 to 64	332	17,309	8,054	0	298
65 to 70	410	17,309	8,054	0	89
>70	797	17,309	8,054	0	0
TOTAL	**4,380**			**19,332**	**11,152**

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	Storage Water Heater	224	1,004	448%	15,060
Custom	Ventilation Reduction	17,131	11,153	65%	167,296
Total		***17,335***	***12,157***	***70%***	***182,356***

The project has 70% realization rate is due to different approached used for storage water heater and different temperature profile used for ventilation reduction. The storage water heater measure falls under TRM methodology and a deemed Therms savings is given regardless of the size or efficiency of the installed unit. Ventilation reduction during unoccupied hours is calculated using TMY3 weather data for Midway airport. The main difference between the ex-ante and ex post calculations is the number of hours per temperature bin. ADM cannot verify the source of temperature bin used in ex ante savings estimation. A comparison of the ex-ante and ex-post hours can be seen in the following table:

Unoccupied Hours at Different Temperature Bin

Temperature Bin	-18	-13	-8	-3	2	7	12	17	22	27	32	37	42	47	52	57	62	65	>70	TOTAL
Ex Post (TMY3)	2	15	16	14	47	52	98	131	109	212	224	355	346	406	488	326	332	410	797	4,380
Ex Ante	2	11	27	53	89	115	164	231	369	580	839	664	469	385	0	0	0	0	0	3,998

Name S-28, C-17

Executive Summary

Application S-28, C-17 consisted of five sites. Building A received standard and custom incentives from DCEO for installation of a Storage Water Heater and cutting down ventilation rate during unoccupied periods via DDC. Building B received custom-measure incentives from Illinois DCEO for installing new fire tube boilers in the powerhouse building. Building C received custom incentives from DCEO for installation of high efficiency burners for their boilers. Building D received custom incentives from DCEO for installation of carbon monoxide and nitrogen oxide sensors in a parking garage to control supply and exhausts to reduce the heating demand on the make-up air handling unit. Building E received custom incentives from DCEO for making HVAC controls improvements. The natural gas project realization rate is 85%.

Project Description

Building A:

The customer installed (4) new high efficiency storage water heaters. DDC reduced ventilation rate on multiple air handlers during unoccupied hours, effectively reduce overall 9,255 CFM of heating load.

Building B:

The customer installed (3) Cleaver Brooks CBEX 200-1400-200ST fire tube boilers to take on the full load of the steam heating plant, while the existing aged water tube boilers remain in-place for back-up.

Building C:

The customer retrofitted three boilers, each with a maximum capacity of 36,500 MBTUH. The intent of this energy retrofit is to replace the burners with high efficiency low turndown modulating burners with new digital combustion management controls and variable speed drive control of the burner motor. This measure will maintain O_2 levels between 3.0 and 5.0. The boilers were furnished with new high efficiency Weishaupt burner package on each of the three boilers, with low turndown, variable speed drive and a new control package. Natural gas savings is the result of a reduction in ventilation airflow and related heating requirements.

Building D:

This project will involve the installation of carbon monoxide and nitrogen oxide sensors in a below ground parking garage to control exhaust and make-up air handlers. The intent of the controls is to reduce the amount of outside air being brought into the parking garage which will result in a reduction of heating energy use. The make-up air handler is deigned to heating incoming outside air to a temperature of 55^{o}F. Originally the fans operated 24/7 at a constant full speed.

Building E:

The customer made HVAC controls improvements to the existing building automation system (BAS). The HVAC controls improvements include: allowing VAV box flow to be reduced, supply air, static pressure, and water loop temperature resets, and schedule changes.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates, took screenshots of the control system, and obtained flue gas combustion test documentation from commissioning of the new hardware.

Building A:

Standard Incentives

For the Storage Water Heater incentives, Illinois TRM Version 2.0, Section 4.3.1 Storage Water Heater was used. The facility installed water heaters that have thermal efficiency of 92%. Per TRM's definition, the thermal efficiency is greater than 88% and the installed equipment are high efficiency storage water heater. The high efficiency units have deemed annual natural gas savings of 251 Therms/year/unit.

Custom Incentives

Energy savings were calculated using engineering equation and outdoor temperature during unoccupied hours.

$$Sensible\ Heat\ Savings\ (Btuh) = 1.08\ \times \left(T_{setpoint} - T_{outdoor}\right) \times \left(CFM_{base} - CFM_{as\_built}\right)$$

Where:

1.08	= Conversion Factor, 1.08 min/hour x Btu/ft^3 °F
$T_{setpoint}$	= Heating system temperature setpoint, 70 °F
$T_{outdoor}$	= Outside air temperature based on TMY3 weather data (°F)
CFM_{base}	= Baseline ventilation airflow rate, 17,309 CFM
CFM_{as_built}	= As built ventilation airflow rate, 8,054 CFM

The HVAC system keeps neutral pressure inside, the system bring equal amount of outside air as the amount of air ventilated out. The total gas savings is calculated as follows,

$$Gas\ Savings\ (Therms) = \frac{\sum_{hour=1}^{8760} Sensible\ Heat\ Savings}{Heating\ System\ Efficiency\ \times 100{,}000}$$

Where:

Heating System Efficiency	= Heating System Efficiency, 83%
100,000	= Conversion Factor, 100,000 Btuh/therm

Building B:

Custom Incentives

The logs were used to determine boiler loading bins which were used in the calculation of the as-built boiler plant efficiency. Baseline boiler plant efficiency calculations were provided by the contractor.

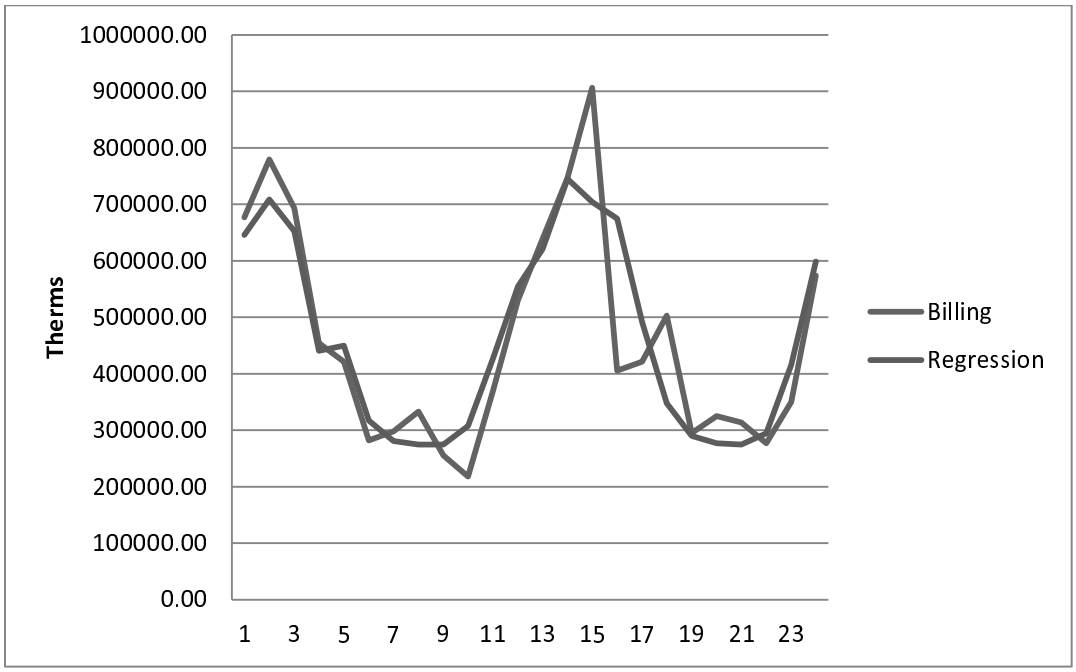
The as-built boiler plant efficiency was calculated using a Department of Energy boiler efficiency calculator in conjunction with combustion reports provided by the site. To calculate savings, a linear regression was performed using baseline boiler plant consumption billing data as the dependent variable and actual monthly heating degree days as the dependent variable, which resulted in an R^2 value of 0.788 and the following regression formula:

$$Therms = 411.9*HDD_{65} + 274{,}568.2$$

Where:

HDD65	= monthly heating degree days with 65F base temp
274,568.2	= base consumption independent of weather

Billing Data vs. Linear Regression



The regression formula was applied to TMY3 monthly heating degree day data to determine typical monthly baseline consumption. The following formula was used to determine typical as-built consumption:

$$Therms_{as\text{-}built} = Therms_{base} * eff_{base} / eff_{as\text{-}built}$$

Where:

$Therms_{as\text{-}built}$	= Annual Therms consumption of the as-built boilers
$Therms_{base}$	= Annual Therms consumption of the baseline boilers

Eff_{base} = Thermal efficiency of the baseline boilers

$Eff_{as\text{-}built}$ = Thermal efficiency of the as-built boilers

Savings is the difference between typical annual baseline and as-built consumption.

Building C:

Custom Incentives

A multiple linear regression model was used to calculate savings. NOAA weather data was downloaded and used to create several independent variables such as temperature, degree days, and others. The dependent variable, Therms consumed per month, was obtained from billing data. The regression model was applied to typical weather in TMY3 format to create pre-retrofit consumption, and post-retrofit consumption was calculated using efficiency values from flue gas measurements. The savings is the difference between the pre and post consumption totals. A Technical Resource Manual (TRM) calculation was completed to support the regression, and the two calculations are in reasonable agreement.

Monthly Boiler Natural Gas Savings

Month	*Baseline*	*As-Built*	*Savings*
Jan	447,007	429,814	17,193
Feb	380,613	365,974	14,639
Mar	350,929	337,432	13,497
Apr	288,896	277,785	11,111
May	236,821	227,712	9,108
Jun	207,948	199,950	7,998
Jul	204,892	197,011	7,880
Aug	193,481	186,039	7,442
Sep	207,635	199,649	7,986
Oct	270,898	260,479	10,419
Nov	331,761	319,001	12,760
Dec	435,971	419,203	16,768
Total			136,802

Building D:

Custom Incentives

Engineering calculations were used to calculate the natural gas savings due to the reduced supply and exhaust flows. Typical weather for the area (TMY3 format) was used to determine the hourly heating requirement for the make-up air handler. The temperature data was combined

with the new ventilation schedule to calculate savings. The hourly heating requirement is calculated using the following equation:

$$Therms = \frac{1.08 \times CFM \times (T_{db,setpoint} - T_{db,OA})}{100{,}000 \times Eff}$$

Where:

Therms	= Hourly Therm consumption of the make-up air handler
CFM	= Flow rate of the incoming air
$T_{db,OA}$	= Dry-bulb temperature of the outside air
$T_{db,setpoint}$	= Dry-bulb temperature setpoint of the discharge air, 55°F
Eff	= Efficiency of the heating system

The hourly flow for the above equations was informed using the following flow profile:

Daily Fan Speed Profile for MUAH

Hour	*% Fan Speed*
0:00	30%
1:00	30%
2:00	30%
3:00	30%
4:00	30%
5:00	50%
6:00	80%
7:00	100%
8:00	100%
9:00	90%
10:00	100%
11:00	100%
12:00	100%
13:00	100%
14:00	90%
15:00	100%
16:00	100%
17:00	80%
18:00	50%

Hour	*% Fan Speed*
19:00	30%
20:00	30%
21:00	30%
22:00	30%
23:00	30%

Building E:

Custom Incentives

Energy savings were calculated using DEER prototypical eQuest modeling. ADM used a DEER prototypical hospital to replicate the energy usage of the facility. The prototypical model's usage was normalized to square footage, and the square footage of the actual building was used to determine realized savings.

Two models were constructed (baseline and as-built). The as-built model included all of the HVAC controls improvements, and the baseline model removed all the improvements. The baseline and as-built models were run using TMY3 weather data for the region. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

As-Built Vs. Baseline Normalized Annual Energy Consumption

End-Use	*Baseline kWh*	*As-Built kWh*	*Annual kWh Savings*	*Baseline Therms*	*As-Built Therms*	*Annual Therm Savings*
Lighting	*595,889*	*595,889*	*0*	*0*	*0*	*0*
Miscellaneous Equipment	*663,600*	*663,600*	*0*	*71*	*71*	*0*
Heating	*0*	*0*	*0*	*37,236*	*4,320*	*32,917*
Cooling	*305,892*	*178,667*	*127,224*	*0*	*0*	*0*
Heat Rejection	*7,186*	*5,077*	*2,109*	*0*	*0*	*0*
Pumps	*177,926*	*83,933*	*93,993*	*0*	*0*	*0*
Fans	*256,082*	*123,498*	*132,584*	*0*	*0*	*0*
Domestic Hot Water	*0*	*0*	*0*	*14,451*	*14,410*	*41*
Total	**2,006,574**	**1,650,665**	**355,910**	**51,758**	**18,800**	**32,958**

Measure-level Gross Savings Results

Building A:

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual Gas Savings for Storage Water Heaters

Measure	*Measure Metrics*					*Annual Gross Therms Savings*	
	Program Type	*Measure Type*	*Qty.*	*Tank Size*	*Building Type*	*Ex Ante*	*TRM-Calculated Ex Post*
Storage Water Heater	TOS	Gas,High Efficiency	4	80 gallons	Education – Primary/Secondary	224	1,004
Total						224	1,004

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Gas Savings for Ventilation Reduction

Temperature Range	*Hours*	CFM_{base}	CFM_{as_built}	*Annual Gross Therms Savings*	
				Ex Ante	*Ex Post*
-20 to -16	2	17,309	8,054	21	21
-15 to -11	15	17,309	8,054	110	149
-10 to -6	16	17,309	8,054	254	151
-5 to -1	14	17,309	8,054	466	122
0 to 4	47	17,309	8,054	729	387
5 to 9	52	17,309	8,054	872	392
10 to 14	98	17,309	8,054	1,145	693
15 to 19	131	17,309	8,054	1,474	821
20 to 24	109	17,309	8,054	2,133	629
25 to 29	212	17,309	8,054	3,003	1,101
30 to 34	224	17,309	8,054	3,839	1,023
35 to 39	355	17,309	8,054	2,639	1,398
40 to 44	346	17,309	8,054	1,581	1,161
45 to 49	406	17,309	8,054	1,066	1,149
50 to 54	488	17,309	8,054	0	1,047
55 to 59	326	17,309	8,054	0	521
60 to 64	332	17,309	8,054	0	298
65 to 70	410	17,309	8,054	0	89
>70	797	17,309	8,054	0	0
TOTAL	**4,380**			**19,332**	**11,152**

Building B:

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for Efficient Boilers

Measure	*Measure Metrics*		*Annual Gross kWh Savings*	
	Baseline Plant Efficiency	*As-built Plant Efficiency*	*Ex Ante*	*ADM Calculated Ex Post*
Steam Boilers	72.6%	88. 7%	859,063	1,030,286
Total			*859,063*	*1,030,286*

Building C:

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for Efficient Boilers

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
Boilers Burners and Controls	531,035	136,802
Total	*531,035*	*136,802*

Building D:

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for Efficient Boilers

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
Garage MUAH Controls	10,348	13,944
Total	*10,348*	*13,944*

Building E:

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual kWh Savings for HVAC Controls Improvements

Measure	*Annual Gross kWh Savings*	
	Ex Ante	*ADM Calculated Ex Post*
HVAC Controls Improvements	-	355,910
Total	-	355,910

Annual Therms Savings for HVAC Controls Improvements

Measure	*Annual Gross Therms Savings*	
	Ex Ante	*ADM Calculated Ex Post*
Above Code Renovations	31,059	32,958
Total	31,059	32,958

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Location*	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
			Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Standard	Building A	Storage Water Heater	224	1,004	448%	15,060
Subtotal			224	1,004	448%	15,060
Custom	Building A	Ventilation Reduction	17,131	11,153	65%	167,296
	Building B	Steam Boilers	859,063	1,030,286	120%	20,605,717[23]
	Building C	Boilers Burners and Controls	531,035	136,802	26%	2,736,040[24]
	Building D	Garage MUAH Controls	10,348	13,944	135%	209,154[25]
	Building E	Above Code Renovations	31,059	32,958	106%	494,371
Subtotal			1,448,636	1,225,144	85%	24,212,578
Total			***1,448,860***	***1,226,147***	***85%***	***24,227,638***

[23] California DEER 2008 EUL expects boiler life span of 20 years
[24] California DEER 2008 EUL expects boiler life span of 20 years
[25] California DEER 2008 EUL expects DCV Control life span of 15 years

Verified Electric Savings/Realization Rates

Incentive Type	*Location*	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
			Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	Building E	Above Code Renovations	-	355,910	N/A	10.00	5,338,649[26]
Total			***-***	***355,910***	***N/A***	***10.00***	***5,338,649***

The project level realization rate is 85%.

Building A has a 70% realization rate, due to different approaches used for storage water heater and different temperature profile used for ventilation reduction. The storage water heater measure falls under TRM methodology and a deemed Therms savings is given regardless of the size or efficiency of the installed unit. Ventilation reduction during unoccupied hours is calculated using TMY3 weather data for Midway airport. The main difference between the ex-ante and ex post calculations is the number of hours per temperature bin. ADM cannot verify the source of temperature bin used in ex ante savings estimation. A comparison of the ex-ante and ex-post hours can be seen in the following table:

Unoccupied Hours at Different Temperature Bin

Temperature Bin	-18	-13	-8	-3	2	7	12	17	22	27	32	37	42	47	52	57	62	65	>70	TOTAL
Ex Post (TMY3)	2	15	16	14	47	52	98	131	109	212	224	355	346	406	488	326	332	410	797	4,380
Ex Ante	2	11	27	53	89	115	164	231	369	580	839	664	469	385	0	0	0	0	0	3,998

For the Building B NORESCO provided a report showing ex ante energy savings. The report indicates that boiler logs and plant efficiency calculations were used to determine the consumption of the baseline boiler plant; however, the determination of as-built plant efficiency is unclear, and it was calculated two months before the commissioning of the boilers, so any calculations would have lacked as-built boiler usage data. ADM calculated the as-built plant efficiency using boiler logs and weather data. The realization rate for this project is 120%.

For Building C the electric realization rate of 26% can be attributed the ex-ante calculation technique, which estimated savings at 1 The lifetime savings were calculated by multiplying typical first year savings by the expected useful life of 15 years. California DEER Effective Useful Life worksheets: EUL_Summary_10-1-08.xls 5% reduction in facility Therm usage. For

26

a boiler efficiency upgrade bumping the combustion efficiency from 80% to around 83%, one would only expect an efficiency increase of around 4%. Both the normalized billing regression and a secondary Illinois TRM V2.0 approach predict realization rates just below 30%.

At Building D the natural gas realization rate of 135% can be attributed the ex-ante calculation using a single average speed and outside air temperature. ADM opted to calculate the annual energy savings by summing the hourly energy savings for an entire year based on hourly flow and temperature data. It was felt that this method is much more accurate than a single data point.

At Building E the ex post found realized electric savings from the reduction in load on the electric HVAC equipment. The ex ante analysis only accounted for gas heating savings. The 106% verified natural gas realization rate is due to the ex post using simulation. The ex ante analysis used a bin calculation which doesn't account for interactive effects like a simulation model does.

Name C-18

Executive Summary

Application C-18 received custom incentives from Illinois DCEO for VAV air handler unit scheduling, minimum outside air position reduction, and reducing exhaust fan operating hours at their facility. The natural gas realization rate is 66%.

Project Description

Three measures were selected; however, only two measures were completed as a result of a retro-commissioning study conducted at the site. The first measure completed was reducing variable air handler units operating hours by 6 hours. The second measure completed reduced the air handler units minimum fan speed. A third measure to reduce exhaust fan operating hours was not implemented by the site.

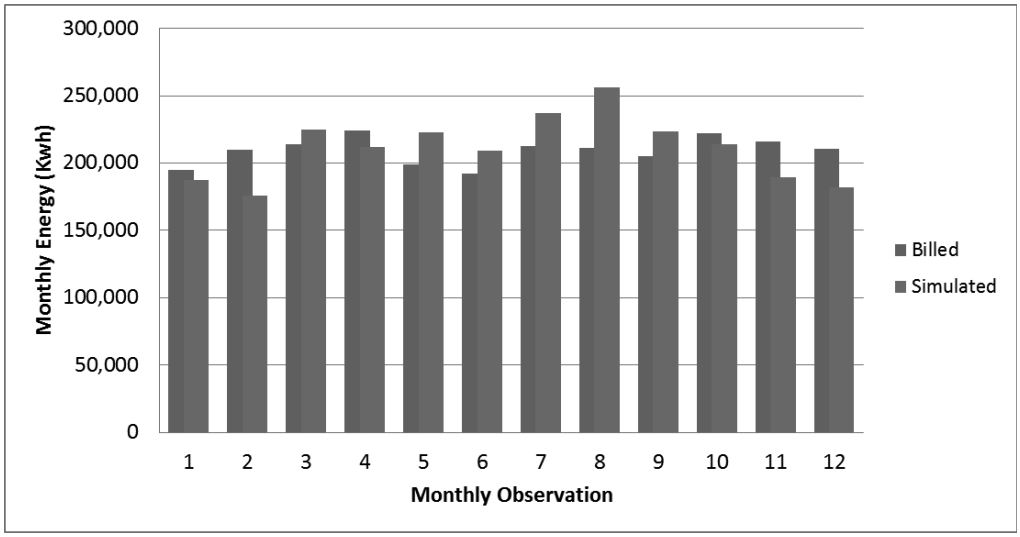
Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified the retro-commissioning measures. To verify the energy savings for the measures, ADM field staff documented equipment nameplates, construction documents, and mechanical schedules. ADM also interviewed site contacts regarding typical facility operation and collected HVAC operational setpoints from the building's energy management system.

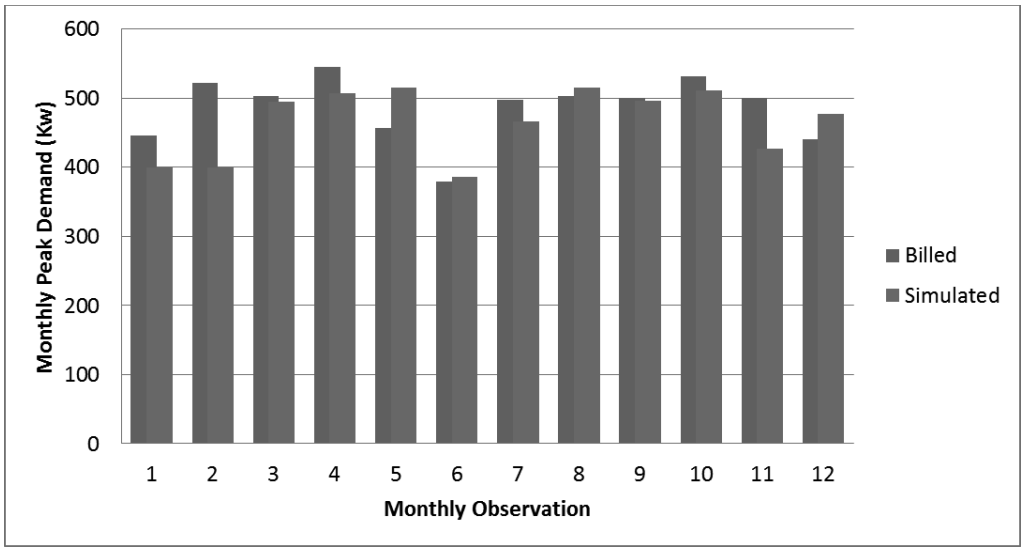
Custom Incentives

Energy savings were calculated using an eQuest model of the fine arts center. ADM compiled a model of the baseline facility using the details and construction documents collected during the on-site M&V visit. Upon completion of the initial model, a custom weather file was created using 2012 NOAA weather data for the Coles County area. Using this weather file and billing data for the facility, ADM ensured that the model's energy load shape matched that of the bills. The results of this calibration effort can be seen below:

2012 Monthly kWh Calibration



2012 Monthly kW Calibration



Upon calibration of the baseline eQuest model, an as-built model was created with the implemented retro-commissioning measures installed. Once the as-built model was completed, the baseline and as-built models were run using Decatur TMY3 weather data. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

As-Built Vs. Baseline Annual Electrical Energy Consumption

End-Use	Baseline kWh	As-Built kWh	Annual kWh Savings
Lighting	513,952	513,952	0
Misc. Equipment	50,669	50,669	0
Heating	0	0	0
Cooling	764,327	660,861	103,467
Heat Rejection	30,492	25,182	5,309
Pumps	622,906	617,144	5,762
Fans	488,880	302,653	186,227
Exterior	0	0	0
Total	**2,471,226**	**2,170,460**	**300,766**

As-Built Vs. Baseline Annual Natural Gas Energy Consumption

End-Use	Baseline Therms	As-Built Therms	Annual Therms Savings
Lighting	0	0	0
Misc. Equipment	0	0	0
Heating	196,531	144,971	51,559
Cooling	0	0	0
Heat Rejection	0	0	0
Pumps	0	0	0
Fans	0	0	0
Exterior	0	0	0
DHW	6,147	6,149	-2
Total	**196,531**	**144,971**	**51,557**

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

Annual Therms Savings for Retro-Commissioning

Measure	*Annual Gross Therms Savings*	
	*Ex Ante**	*ADM Calculated Ex Post*
Reduce AHU operating hours	47,600	28,564
Reduce exhaust fan operating hours	9,400	0
Reduce AHU minimum VAV settings	21,000	22,993
Total	78,000	51,557

*The ex ante measure level values don't match the claimed total; therefore, they were adjusted to reflect the claimed total.

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	AHUs, Fans	-	300,766	-	28.7	1,503,825
Total		**-**	***300,766***	**-**	***28.7***	***1,503,825***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	Reduce AHU operating hours	47,600	28,564	60%	142,820[27]
Custom	Reduce exhaust fan operating hours	9,400	0	0%	0
Custom	Reduce AHU minimum VAV settings	21,000	22,993	109%	114,965
Total		***78,000***	***51,557***	***66%***	***257,785***

The project has an overall natural gas realization rate of 66%. The 66% verified natural gas realization rate is due to the site not fully implementing all of the measures. The AHUs scheduling measure was to reduce the operation of the air handlers at night by 6 hours; however, three air handler units were setback fewer than 6 hours. This resulted in a 60% realization for that measure. If all the AHUs were setback 6 hours, the realization rate would have been 100%. The exhaust fan measure was not implemented by the site. The minimum VAV setting measure has a realization rate greater than 100% because of its interaction with the scheduling measure. All the AHUs were not setback the full 6 hours, so more energy savings were realized because of the increased post operating hours.

The project also realized electric saving. The ex ante did not claim any electric savings; therefore, the savings is captured, but without the realization rate.

[27] The lifetime savings were calculated by multiplying typical first year savings by the expected useful life of 5 years. http://cx.lbl.gov/documents/2009-assessment/lbnl-cx-cost-benefit.pdf

Name C-19

Executive Summary

Application C-19 received custom incentives from Illinois DCEO for upgrading from pneumatic controls to a DDC control system with occupancy based HVAC controls. The electric realization rate for this project is 66%, and the natural gas realization rate is 127%.

Project Description

The facility converted their existing pneumatic HVAC control system to Direct Digital Controls (DDC) in order to increase the energy efficiency of their facility. With the addition of the DDC system, the HVAC system that once operated 24/7, regardless of occupancy, was able to be scheduled to only operate during periods of occupancy. The DDC system also allowed for the addition of static pressure resets, temperature setbacks, discharge temperature resets, and economizer optimization.

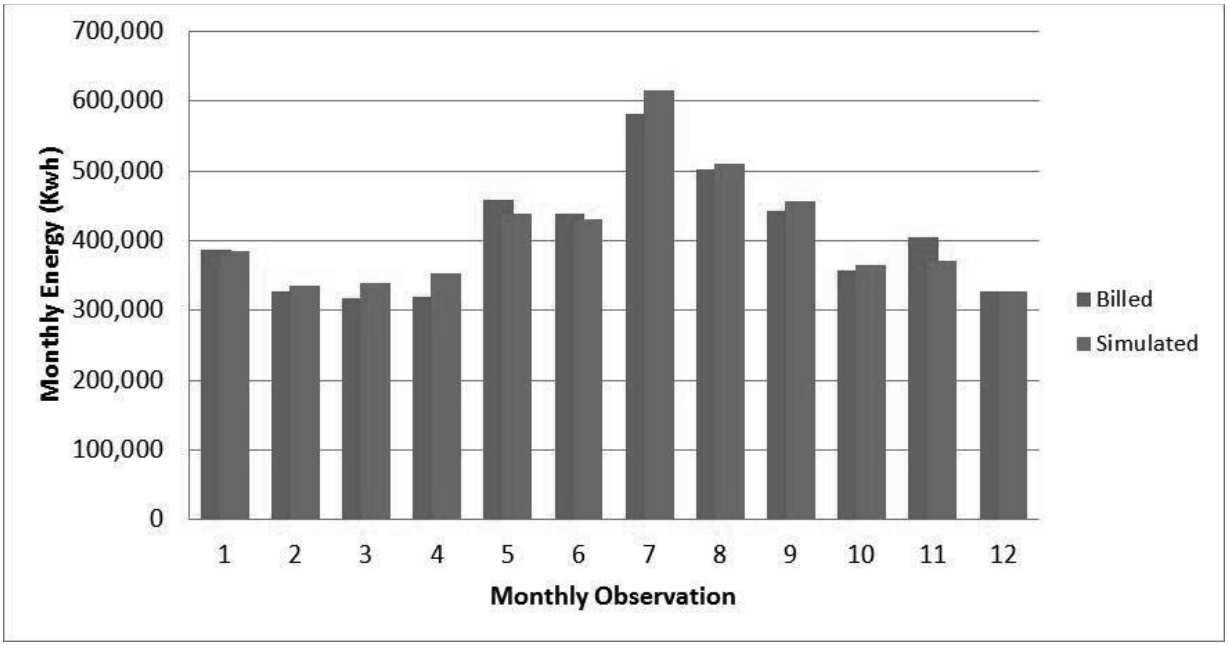
Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified the new DDC system and control strategies had been implemented. To verify the energy savings for the measures, ADM field staff documented equipment nameplates, construction documents, and mechanical schedules. ADM also interviewed site contacts concerning typical facility operation and collected HVAC operational setpoints from the building's Energy Management System (EMS).

Custom Incentives

Energy savings were calculated using an eQuest model of the facility. ADM compiled a model of the baseline facility using details and construction documents collected during the on-site M&V visit and provided in the project application. Upon completion of the initial model, a custom weather file was created using 2013 NOAA weather data for the Rockford, IL area. Using this weather file and billing data for the facility, ADM was able to ensure that the model's energy load shape matched that of the bills within a normalized mean biased error of 2%. The results of this calibration effort can be seen below:

2013 Monthly kWh Calibration



Upon completion of the calibration for the baseline eQuest model, an as-built model was created using information from the as-built Sequence of Operations (SOOs) provided by the site contacts and details collected through the EMS interface. The SOOs detail the control strategies being used by the building's new DDC system. Once the as-built model was completed, the baseline and as-built models were run using Rockford, IL TMY3 weather data. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

As-Built Vs. Baseline Annual Electrical Energy Consumption

End-Use	*Baseline kWh*	*As-Built kWh*	*Annual kWh Savings*
Lighting	*1,370,562*	*1,370,562*	*0*
Misc. Equipment	*947,352*	*947,352*	*0*
Heating	*631,846*	*337,189*	*294,657*
Cooling	*1,015,342*	*566,135*	*449,207*
Heat Rejection	*0*	*0*	*0*
Pumps	*119,579*	*116,721*	*2,858*
Fans	*408,847*	*197,503*	*211,344*
Exterior	*491,585*	*491,585*	*0*
Total	**4,985,113**	**4,027,047**	**958,066**

As-Built Vs. Baseline Annual Natural Gas Energy Consumption

End-Use	Baseline Therms	As-Built Therms	Annual Therm Savings
Lighting	0	0	0
Misc. Equipment	0	0	0
Heating	130,853	40,969	89,884
Cooling	0	0	0
Heat Rejection	0	0	0
Pumps	0	0	0
Fans	0	0	0
Exterior	0	0	0
Total	**130,853**	**40,969**	**89,884**

Measure-level Gross Savings Results

Custom Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual kWh Savings for DDC Retrofit

Measure	Annual Gross kWh Savings	
	Ex Ante	ADM Calculated Ex Post
DDC Retrofit	1,457,551	958,066
Total	1,457,551	958,066

Annual Therms Savings for DDC Retrofit

Measure	Annual Gross Therms Savings	
	Ex Ante	ADM Calculated Ex Post
DDC Retrofit	70,547	89,884
Total	70,547	89,884

Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

Verified Electric Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*				*Lifetime Gross Savings*
		Ex-Ante kWh	*Ex Post kWh*	*Realization Rate*	*Ex Post Peak kW Reduction*	*Ex Post kWh*
Custom	DDC Retrofit	1,457,551	958,066	66%	102.55	14,370,990
Total		***1,457,551***	***958,066***	***66%***	***102.55***	***14,370,990***

Verified Natural Gas Savings/Realization Rates

Incentive Type	*Measure Category*	*Annual Gross Savings*			*Lifetime Gross Savings*
		Ex-Ante Therms	*Ex Post Therms*	*Realization Rate*	*Ex Post Therms*
Custom	DDC Retrofit	70,547	89,884	127%	1,348,260
Total		***70,547***	***89,884***	***127%***	***1,348,260***

The project has an overall electrical realization rate of 66% and a natural gas realization rate of 127%. The 66% verified electric realization rate is due to the ex-ante Trane Trace model not being calibrated to annual bills. It can be concluded that the over estimation in baseline energy consumption by the ex-ante model resulted in an overestimation in energy savings.

Name S-29

Executive Summary

Application S-29 received standard incentives from Illinois DCEO for installation of a high efficiency boiler and boiler controls. The natural gas realization rate is 51%.

Project Description

The customer installed (2) new high efficiency boilers and boiler controls. The installed boilers have an efficiency of 92% AFUE.

Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verity the installed equipment, ADM field staff documented unit nameplates and collected information about the controls.

Standard Incentives

Energy savings were calculated according to the Errata Corrected Illinois TRM Version 3.0.

For the boilers, TRM Section 4.4.10 High Efficiency Boiler was used.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = EFLH * Capacity * (EfficiencyRating(actual) - EfficiencyRating(base)) / EfficiencyRating(base) / 100{,}000$$

Where:

EFLH	= Equivalent Full Load Hours for heating (see table)
Capacity	= Nominal Heating Capacity Boiler Size (btuh)
	= custom Boiler input capacity in Btu/hr
EfficiencyRating(base)	= Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section
EfficiencyRating(actual)	= Efficent Boiler Efficiency Rating use actual value

For the boiler controls, Section 4.4.4 Boiler Lockout/Reset Controls was used.

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = Binput * SF * EFLH / (100)$$

Where:

Binput	= Boiler Input Capacity (kBTU)
	= custom
SF	= Savings factor
	= 8% or custom

EFLH = Equivalent Full Load Hours for heating (see table)

Measure-level Gross Savings Results

Standard Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

Annual Therms Savings for High Efficiency Boiler

Measure	*Program Type*	*Boiler Capacity (BTUH)*	*Base Boiler Type*	*Efficient Measure*	*Zone*	*Building Type*	*Annual Gross Therms Savings*		
							Ex Ante	*TRM-Calculated* *Ex Post*	*TRM-Calculated (Errata Corrected)* *Ex Post*
High Efficiency Boiler	RF	4,000,000	Hot Water ≥300,000 & ≤2,500,000 Btu/h	92%	2 (Chicago)	Religious Facility	4,395	10,807	9,942
Total							4,395	10,807	9,942

Annual Therms Savings for Boiler Controls

Measure	*Program Type*	*Boiler Capacity (kBTUH)*	*Zone*	*Building Type*	*Annual Gross Therms Savings*		
					Ex Ante	*TRM-Calculated* *Ex Post*	*TRM-Calculated (Errata Corrected)* *Ex Post*
Boiler Lockout/ Reset Controls	RF	4,000	2 (Chicago)	Religious Facility	20,256	6,628	5,302
Total					20,256	6,628	5,302